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Econometric study on Malaysia's palm oil position in the world market to 2035

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A B S T R A C T

Malaysia is currently the world's second largest producer of palm oil. With its large and growing palm oil industry, combined with a strong global demand for palm oil, Malaysia has the potential to play a major role in the world food and biofuel markets. As a result of environmental concerns and reservations concerning the net effect of deforestation in some countries such as Indonesia, a restricted expansion of palm oil plantation area has been analyzed. This paper aims to perform a quantitative analysis on (1) the domestic supply and demand outlook for Malaysia's palm oil, including biodiesel demand and (2) its ability to supply the global markets by 2035, in the context of restricted plantation area.

Domestic palm oil production is projected to rise by about 50% to 26.6 million tons in 2035. Domestic demand of palm oil for food consumption, industrial non-food uses and biodiesel is anticipated to increase by more than 200% to 1.4 million tons in 2035, up from 0.4 million tons in 2009. Domestic demand, however, amounts to only a very small portion (5%) of total palm oil production in 2035, with an expected exportable surplus of over 25 million tons. With such surplus capacity, Malaysia will become a formidable competitor in the world vegetable oil and biofuel markets.

Contents

1. Introduction

Palm oil is an important and versatile raw material for both the food and the non-food industries. It is the largest constituent of edible oil, accounting for 30% or some 56 million tons of world oil and fats production in 2012 [1], replacing coconut oil and tallow as the main feedstock for the global oleo-chemical industry [2].

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Global dependence on palm oil will continue to rise in years ahead owing to insufficient production of other oils and fats. It is anticipated that in 2020, at least 78 million tons of palm oil will be required by consumers worldwide [1]. Palm oil is also becoming a more important raw material for transport biofuels. Rising oil prices along with strong intention to reduce greenhouse gas (GHG) emissions within the transport sector has driven up demand for palm oil as a feedstock for transport biofuel, owing largely to its higher yields and price advantage compared with other vegetable oils such as soybean, sunflower or rapeseed [1,3,4]. In 2013, 4.6 million tons of palm oil was used globally for biodiesel production, accounting for about 30% of biodiesel feedstock [4].

Palm oil was introduced to the peninsula of Malaysia as an ornamental plant by the British in the 1870s. Its economic potential was first realized in the 1960s when the Malaysian government embarked on a poverty eradication program through agricultural diversification by planting palm oil to complement its rubber production [5]. Malaysia is currently the second largest palm oil producer in the world, accounting for close to 28% of global trade of vegetable oils in 2011 [6]. Between 2006 and 2013 Malaysia exported 900 thousand tons of palm biodiesel, mainly to Europe and the USA [7] (Fig. 1). The domestic market for palm oil also plays an important role in supporting Malaysia's economy (see Table 1). It dominates local edible oil market and is the indigenous raw material to the oleo-chemical [8] and the food industries in Malaysia, which generated some 80 billion ringgit Malaysia of exports earnings in 2011 [6]. Malaysia's large and growing palm oil industry has the potential to play a major role in global food and biofuel markets. This paper aims to perform a quantitative analysis on (1) the domestic supply and demand outlook for Malaysia's palm oil, including biodiesel demand and (2) Malaysia's ability to supply the global markets to 2035, in the context of restricted expansion for new palm oil plantation areas.

This paper is organized as follows. Overviews of the model structure and methodology are provided in Section 2, followed by the results and analysis in Section 3. Updates on the recent developments of the biodiesel industry in Malaysia are provided in Section 4. An overall picture on the sustainability aspect of palm oil production is presented in Section 5. Finally, Section 6 gives the conclusion.

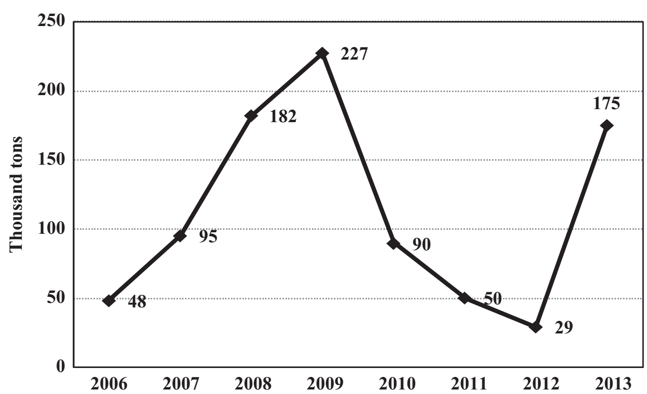

Fig. 1. Malaysia palm biodiesel exports.
Source: compiled from [7].

Table 1
Palm oil industry in Malaysia as of 2009.
Source: compiled from [9,10].

Plants/plantation area	Peninsular Malaysia	Sabah	Sarawak
Plantation area (million hectare)	2.56	1.44	1.08
Palm oil mills			
no. of plants	248	124	57
annual capacity (million ton)	56.8	32.1	13.1
Refinery plant			
no. of plants	36	12	6
annual capacity (million ton)	15	7.5	2.4
Oleochemical plant (Malaysia)			
no. of plants	17		
annual capacity (million ton)	2.6		
Operating biodiesel plant (Malaysia)			
no. of plants	10		
annual capacity (million ton)	1.5		

2. Methodology

2.1. Overview of model structure

Fig. 2 shows a schematic flow of this study. A palm oil sub-model was developed to linked with our integrated econometric model [11,12] for this study. The palm oil sub-model is designed to determine domestic demand and supply, as well as export potential of palm oil; in other words, the palm oil sub-model projects total production and assesses where it will most probably be used. The integrated econometric model which consists of a macroeconomic sub-model and an energy–environment sub-model provides macroeconomic indicators which influence domestic demand for palm oil such as gross domestic production (GDP) and population.

The variables projected in this study are the domestic production of palm oil and the domestic demand of palm oil for food, other uses, and waste. For the demand–supply analysis of Malaysia palm oil in this study, we refer to the supply utilization account (SUA) methodology of FAO [13]. The SUA is an accounting identity, showing for any year the sources and uses of agricultural commodities in homogenous physical units, shown as follows:

$$\begin{aligned}&\text{food(directconsumption)} + \text{industrial non} - \text{food uses}\\&\quad + \text{feed} + \text{seed} + \text{waste} = \text{total domesticuse} = \text{production}\\&\quad + (\text{imports} - \text{exports}) + (\text{openingstocks–closingstocks}) \qquad (1)\end{aligned}$$

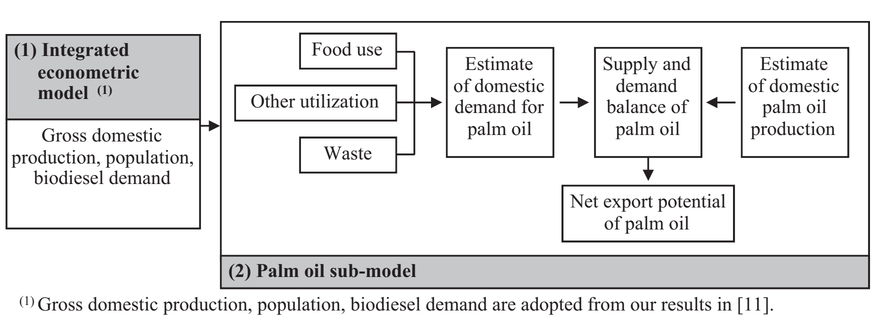

Fig. 2. Overview of this study.

Table 2
Main assumptions for this study.

Macroeconomic indicators	1990–2010	2010–2020	2020–2035	2007–2035
I. Indicator (annual growth rate, %)				
Gross domestic production	6.6	4.8	4.3	4.5
Population	2.3	1.5	1.1	1.2
II. Indicator (level)	2010	2020	2030	2035
Per capita GDP (USD/capita)	5499	7263	9641	11,095
Crude oil prices (USD/BBL)	52.3	114.3	159.6	188.6
Palm oil related assumptions	2012	2020	2030	2035
FFB yield (t/ha)	18.9	21.9	24.7	26.2
Yield rate of palm oil from a ton of FFB	0.2	0.2	0.2	0.2
Plantation area (million hectare)	5.1	5.1	5.1	5.1
Palm oil prices (CIF Rotterdam Price) (USD/Metric Ton)	1000	1034	1309	1472

Domestic production of palm oil as showed in Eq. (2) is estimated using an exogenous assumption on fresh fruit bunch (FFB) yield per hectare as targeted in the government's plan [14]. Additionally, we also assume the restricted expansion of new palm oil plantation areas in response to concerns and arguments over the sustainability of palm oil production [15,16]. Hence, plantation area is assumed to remain constant at 2012 level till 2035 and FFB yield per hectare is assumed to reach 26.2 t in 2035 as shown in Table 2. Palm oil yield[1] from a ton of FFB is assumed to average 0.2 t in this study. Future increment in palm oil production is achieved fundamentally through improvement of FFB yield per hectare.

$$\mathrm{PALMOIL} = \mathrm{PALMAREA}(\mathrm{FFBY} \times Y) \tag{2}$$

where PALMOIL is the domestic production of palm oil, PALMAREA the plantation area of palm oil, FFBY the fresh fruit bunch yield and Y the yield of palm oil from a ton of FFB.

Domestic demand for palm oil comprises food use, other utilization and waste. Palm oil for food use is obtained by simple multiplication of per capita palm oil consumption with population, where per capita consumption is estimated as a function of per capita GDP and relative prices of palm oil and crude oil. Other utilization consists of industrial non-food uses and domestic biodiesel use. Industrial demand for non-food uses is projected as a function of the GDP whereas domestic B5 blending of palm oil based biodiesel beginning 2011 is obtained from our projections in Gan et al. (2013) [11]. Waste (post-harvest to retail) is projected as a proportion of total palm oil supply (namely production plus imports) as per the FAOSTAT [17]. Palm oil potential available for export is derived as the balance between domestic supply and demand of palm oil.

2.2. Data and assumptions

Palm oil data from 1961 to 2009 are obtained from FAOSTAT [17]. Palm plantation area and FFB yields data from 1975 to 2012 are obtained from official statistics of Malaysia Palm Oil Board [9]. Macroeconomic indicators such as per capita GDP, population and crude oil prices are obtained from the results of our integrated econometric model in Gan et al. (2011) [11]. Assumptions on palm oil prices are adopted from World Agricultural Outlook 2011 of FAPRI-ISU [18]. Estimation of plantation area required to meet domestic demand for palm oil is based on the targeted FFB yield per hectare of plantation [14] and a constant yield rate of palm oil (or crude palm oil, CPO) from a ton of FFB throughout projection period [9,19]. Major assumptions underlying our projections are summarized in Table 2. The projection period is from 2010 to 2035.

3. Results and discussions

3.1. Outlook of palm oil supply and demand to 2035

Domestic palm oil production is projected to rise by about 50% between 2009 and 2035, increasing from 17.6 million tons in 2009 to 22.2 million tons in 2020, and 26.6 million tons in 2035 as showed in Fig. 3.

On the demand side, domestic food use for palm oil is expected to more than triple from 0.168 million tons in 2009 to 0.529 million tons in 2035, following a steady increase in per capita demand of palm oil for food consumption as showed in Fig. 4. Industrial non-food use of palm oil in Malaysia is projected to reach 0.346 million tons by 2035, up from 0.173 million tons in 2009, on account of steady economic growth and strong demand.

The biodiesel industry is projected to represent a significant source of demand following the implementation of B5 blending which began in 2011. By 2035, the use of biodiesel is anticipated to reach 0.4 million tons and account for 28% of total palm oil consumption. Altogether domestic demand of palm oil as food, industrial non-food uses and biodiesel will increase to 1.404 million tons in 2035, up from 0.44 million tons in 2009. This however amounts to only less than 6% of total production in 2035; a hike of blending rate by B10 in 2014 as planned by the government will translate into an additional small share to total consumption which is still insignificant when compared against the production volume.

In terms of the acreage required to fulfill future domestic demand for palm oil till 2035, based on an assumed yield rate of palm oil from a ton of FFB as showed in Table 2, it is projected that 5.3% of total plantation area would be sufficient as shown in Fig. 5. In other words, existing level of production is more than ample to supply the local market even without new addition of plantation areas till 2035.

Coconut oil has been the main edible oil consumed in Malaysia, supplying close to 80% of vegetable oil consumption in 1960. Along with the expansion of commercial planting of palm oil beginning in the 1960s, demand for palm oil has increased with population growth, increased per capita consumption and as the consumers moved away from coconut oil. Today, palm oil is the main edible oil consumed in Malaysia accounting for close to 40% of vegetable oil consumption [17].

[1] The yield of FFB and palm oil in 2012 was 18.89 t/ha and 3.84 t/ha respectively. Hence, every ton of FFB yields approximately 0.2 t of palm oil. Between 1990 and 2012 the yield rate averaged at 0.2 t, with a range of 0.18–0.20 t [9].

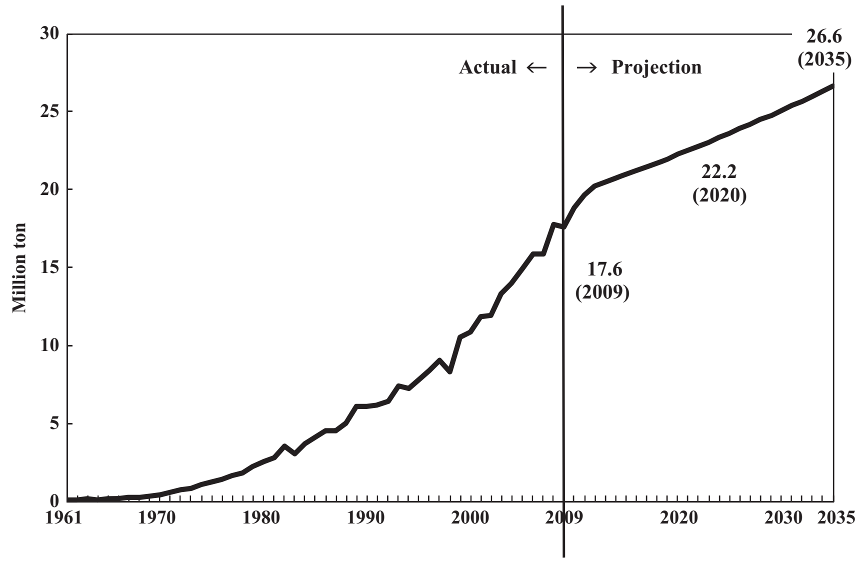

Fig. 3. Domestic palm oil production to 2035.

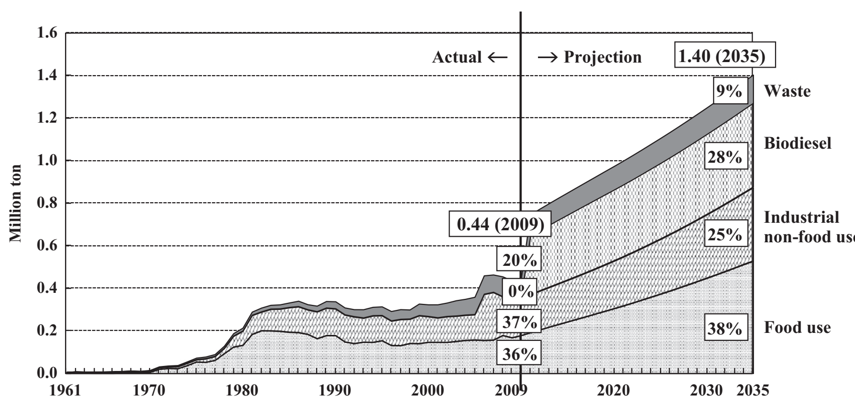

Fig. 4. Domestic demand for palm oil to 2035.

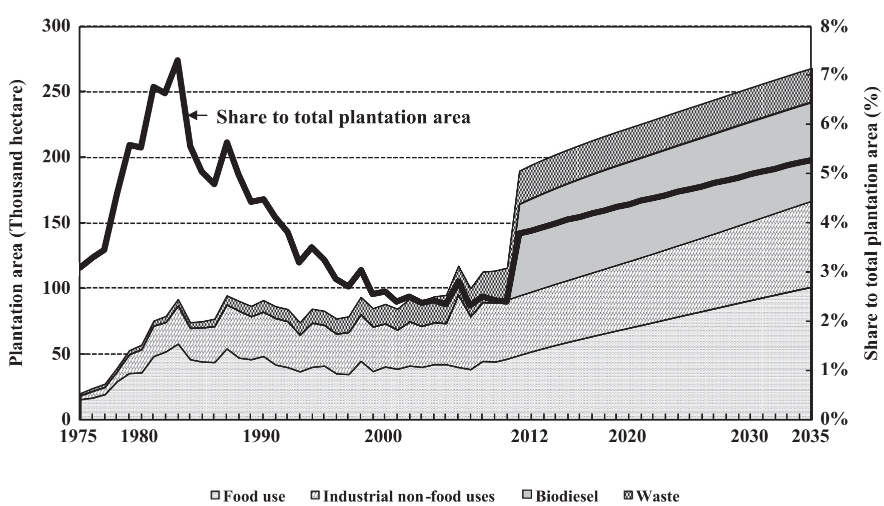

Fig. 5. Estimation of amount of plantation area required to meet future demand.

Over the projection period, economic growth and population increases are projected to boost up food demand of palm oil. Per capita palm oil consumption is projected to rise to 13.7 kg by 2035, up from 6 kg in 2009, supported by the vast availability of home grown palm oil and the strengthening global competition for soybean, in particular from China, India and the European Union (EU) which will significantly limit any increase of soybean oil consumption in the future [13,20]. Along with this increment, the

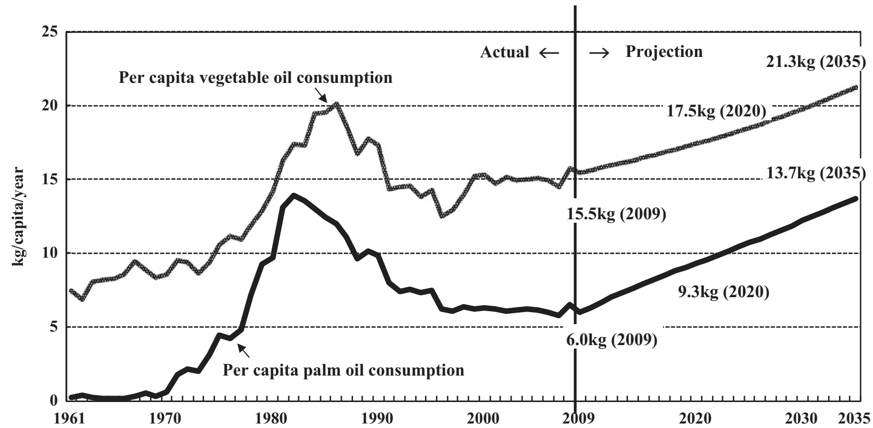

Fig. 6. Per capita consumption of palm oil in Malaysia to 2035.

Table 3
Comparison with other studies.
Source : compiled from [13,18,21,22].

Study	2009	2015	2020	2025	2030	2035	2050
I. Per capita vegetable oil consumption (kg/year)							
This study	14.6	16.5	17.5	18.5	19.8	21.3	-
FAO, 2003							
East Asia[a]	–	13	–	–	16	–	–
Developing countries	–	13	–	–	15	–	–
Industrial countries	–	22	–	–	23	–	–
FAO, 2012							
East Asia[a]	–	–	–	–	13.8	–	15.3
Developing countries	–	–	–	–	13.1	–	15.4
Developed countries	–	–	–	–	20	–	21
OECD-FAO, 2011							
Developing countries	15.5	16.5	17.6	–	–	–	–
Malaysia	22.7	26	28.6	–	–	–	–
II. Per capita palm oil consumption (kg/year)							
This study	6.1	7.9	9.3	10.7	12.2	13.7	
FAPRI, 2011[b]	30	38	41	43	–	–	–

[a] Includes Cambodia, China, Indonesia, Korea Dem. Rep., Korea Rep., Lao PDR, Malaysia, Mongolia, Myanmar, Philippines, Thailand, Vietnam.
[b] Relatively higher projections compared with this study. This might be an estimation of per capita palm oil consumption including both food and non-food uses.

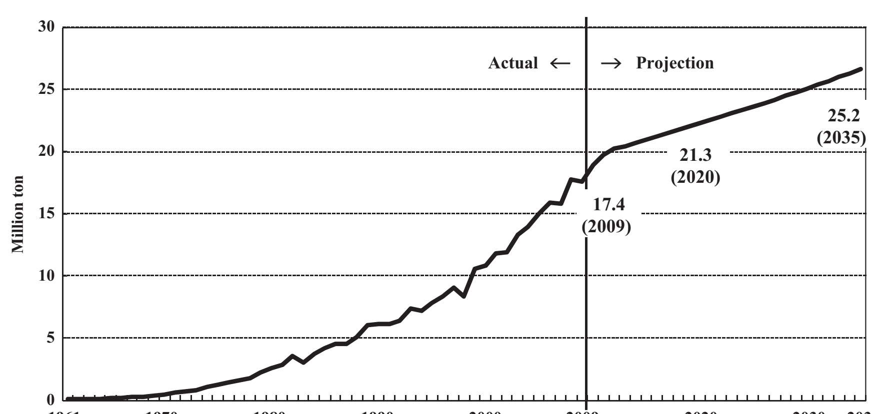

Fig. 7. Outlook of palm oil available for exports to 2035.

share of palm oil in total vegetable oil consumed as food is anticipated to increase from 39% in 2009 to 64% in 2035 as shown in Fig. 6.

Compared with other studies FAPRI-ISU (2011) [18], the 2011 World Agricultural Outlook, estimated 43 kg of per capita palm oil consumption for Malaysia in 2025, a considerably much higher estimation than the 10.7 kg obtained in this study as it most probably includes also the industrial uses (see Table 3). In terms of per capita vegetable oil consumption this study estimates 21.3 kg in 2035, whereas OECD-FAO (2011) [21] projected 28.6 kg in 2020.

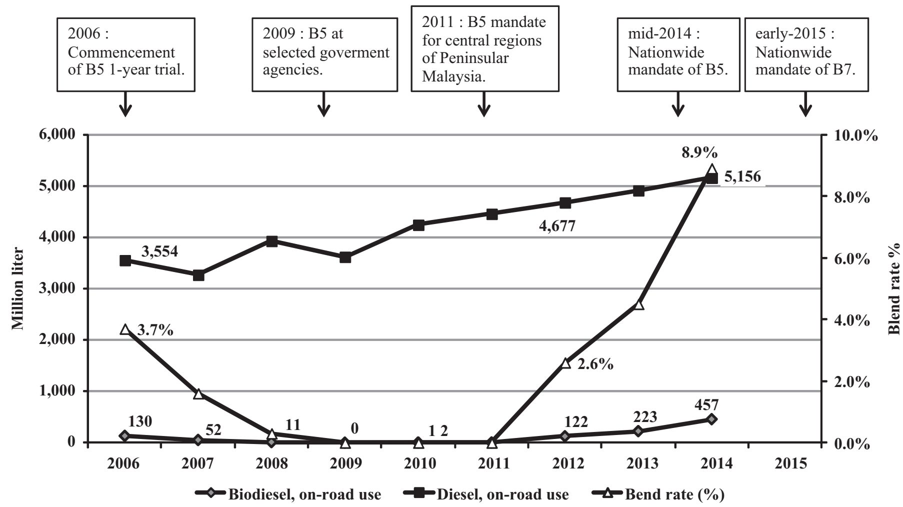

Fig. 8. Market penetration of palm biodiesel.
Source: compiled from [10,15,28,31,33].

Taking into account the data differences for base year – 2009 between OECD-FAO and this study, OECD-FAO estimation for 2020 would be approximately 18.4 kg, which is closer to our projection.

3.2. Outlook of palm oil's export potential to 2035

Malaysia has been a leading exporter of palm oil, reflecting the country's large production and refining capacities, its small domestic market, and an export tax structure that favors palm oil products over CPO.[2] The bulk of palm oil output available for exports is expected to increase to 25.2 million tons in 2035, up from actual trade volume of 17.4 million tons in 2009 as shown in Fig. 7. According to OECD-FAO (2011) [21], worldwide demand for vegetable oil as food and biofuel combined will reach 182 million tons in 2020. The bulk of future increases in food consumption of developing countries is expected to come from vegetable oils and its products, with a growing share of four oilcrops namely oil palm, soybean, rape and sunflower in total oilcrops sector [13,22]. Oil World estimated that at least 78 million tons of palm oil will be required by consumers worldwide in 2020 [1]. With an expected exportable surplus of over 25 million tons in 2035, Malaysia will remain a formidable competitor in the world vegetable oil and biofuel markets.

4. Updates on domestic use of palm biodiesel

Palm biodiesel at 5% blending was launched for 1-year trial in 2006 and later implemented as a mandate in late 2011 in selected regions of Peninsular Malaysia. Despite its importance as one of the renewable energy sources [23–29], until the end of 2012, relatively high palm oil prices, insufficient incentives and supports hindered advancement of the biodiesel sector. Biodiesel use is still low and the average national blend rate has been below 5% (Fig. 8). Production capacity sits idle and is operating at less than 10% capacity [10,30]. The government is currently attempting to implement a B7 mandate by early-2015.[3] However, the pace of the B5 implementation is lagging and achieving the B7 goal is questionable.

So far, the biodiesel industry focused mainly on the export markets; domestic use of B5 was intended more as a mean to boost demand for palm oil, which would then ease domestic stock pressure [31,32]. To succeed a full implementation of B5, let alone B7 in the near term as planned, government commitment is necessary as current level palm oil prices are not profitable to producers without subsidies and not attractive to consumers of B5 because petroleum based diesel is priced the same. It is essential for the government to mobilize the establishment of fuel standards involving automobile manufacturers to ease public acceptance of B5 biodiesel, develop marketing infrastructure which is currently insufficient and form the appropriate pricing strategy to build the essential foundation from which a successful B5 program could be implemented.

Table 4
Changes in plantation areas of major crops in Malaysia.
Source: compiled from [47].

Year	Oil palm	Rubber	Cocoa	Coconut	Total
1990	2.03	1.84	0.39	0.31	4.57
2008	4.49	1.25	0.02	0.11	5.87
Addition of new plantation areas	2.46	−0.59	−0.37	−0.20	1.29

5. Sustainability of palm oil

Palm oil is perceived as closely linked to illegal logging and diminishing biodiversity. The expansion of palm oil plantations is said to be the leading cause of deforestation in Southeast Asia, in particular Malaysia and Indonesia, and spurred debates on the environmental impacts from land use change. Studies either slammed palm oil on account of its unsustainable practices which could potentially negate its environmental benefits when used as biofuels or attempted to present discussions from different perspectives [3,15,16,34–40].

Environmental NGOs, especially in the EU, have been extremely concerned and attempted to address these by applying sustainability criteria to palm oil imported into the EU. A number of trade restrictions now exist in response to these pressures. The EU's Renewable Energy Directive was amended in September

[2] In an effort to reduce high stocks of CPO in Malaysia, the Malaysian government has allowed selected companies to export a pre-determined quantity of CPO annually without any export duty. For instance, the approved volume of duty-free CPO export in 2001 was 1 million ton [8].

[3] The initial proposal was a B10 mandate by mid-2014.

2013 to include a new sustainability provision of 6% cap on biofuels produced from food crops or from crops grown on land that was previously occupied by other vegetation [41]. New EU ingredient labeling rules that compel manufacturers to indicate on labels the type of vegetable oil used which are currently labeled as vegetable oil in general will come into force in December 2014 [42]. Additionally, a revised tax rate which will see a 400% increase in tax imposed on palm oil was passed in France in late 2012 [43]. In the US, palm oil was disqualified as renewable fuel under the Renewable Fuel Standard program [44]. In Australia, a new bill on palm oil labeling was passed in 2011 [45].

One of the negative consequences of accommodating the economical and social needs in Malaysia through palm oil plantation expansions was the rapid deforestation which happened until the beginning of the 1980s. However, some case studies also confirmed that palm oil expansion has often replaced other permanent crops such as natural rubber, cocoa and coconut (Table 4). Currently, over 50% of the country's land is still covered by tropical forests [3,46].

At a relatively higher yields of per hectare output, Malaysia's palm oil on average supplies more than 10% of global oils and fats production annually while occupying less than 2% of worldwide oilcrops harvested areas [17]. According to MPOB [9], palm oil yields in recent years varied largely by states, so there is room for productivity improvements. The Malaysian government had also allocated a budget of 432 million ringgit Malaysia for financial year 2013 as subsidy to assist replanting of unproductive palm plantation areas to improve the overall productivity [48]. IEA projected that replacing 27% of transport fuel (or 760 million tons of oil equivalent) with biofuels by 2050 would require around 100 million hectares of land in 2050, up from 30 million hectares in 2010 [49]. Due to land constraints, the EU biodiesel sector will consume 40% more palm oil than 2012 level by 2020 to fulfill the 10% target [50]. Achieving higher output through yield improvements as illustrated in this study contributes to reduced land requirements. Diverting palm oil plantation to degraded land is found to be effective in achieving significant emissions reductions [51].

In terms of greenhouse gas (GHG) emissions, studies indicated that biofuels reduce GHG emissions when the effects of land use change are excluded. Palm oil outperformed other oilcrop feedstocks such as soybean and rapeseed on account of its higher yields. When biofuels production requires the conversion of forest the net GHG reduction would not be achievable for a wide range of biofuel feedstocks, including corn, sugarcane, soybean, rapeseed and palm oil [49,52–56]. Reports by the European Commission, however, also highlight that the quantification of land use change is still subject to great uncertainty in terms of methodology, hence rendering further studies necessary [57,58].

The unintended negative impacts on land, water and biodiversity are not specific to palm oil production. They are among the side-effects of agricultural production in general and its potential environmental and social implications must be recognized and addressed properly with respect to biofuels. The alternative would be a transition to second generation biofuels, yet studies indicated that they will also compete with food use through land use and still subject to a number of technical and economic barriers for commercialization [53,59–64]. A number of sustainability schemes are currently available and have set out strict standards for responsible palm oil plantations, coupled with an independent auditing system which covers the entire supply chain such as that practiced by the Roundtable for Sustainable Palm Oil (RSPO) where palm oil growers, oil processors, manufacturers, NGOs are members. Trading of sustainable palm oil certified under such scheme has begun since 2008 [65].

6. Conclusion

This study analyzed domestic supply and demand outlook of Malaysia's palm oil, as well as its ability to supply global markets to 2035 under restrictions for new plantation areas using a palm oil sub-model which was linked to our integrated econometric model. Our results indicated that domestic production of palm oil will increase to 26.6 million tons in 2035 due to yield improvements. Domestic demand for palm oil will account for less than 6% of total production in 2035, with a surplus of over 25 million tons available for export. Even without yield improvements, current production is more than ample to support a B7 mandate; however, domestic biodiesel market is not expected to take off in the near term as fundamental policy measures and infrastructures are currently lacking.

As the dominant edible oil consumed worldwide and one of the important biofuel feedstocks, expected growth in global food and biofuel markets will continue to boost demand for palm oil. Nonetheless, along with growing interests on its potential as transport fuels in recent years, concerns over the sustainability aspect of palm oil production have also increased and stirred up new debates on land use change which led to the development of a number of new trade restrictions that are expected to further limit its market access.

It is therefore essential for palm oil producers to address these concerns to maintain and strengthen its role in the growing global food and biofuel markets. Increased output through productivity improvements such as yields and agricultural practices, replanting of unproductive and less economical plantation areas, and effective use of degraded land could help reduce competition for land while achieving environmental goal. The adoption of sustainable and responsible palm oil production practices as promoted through the RSPO initiative and compliance with international fuel quality standards facilitate access to global market.

The world will need more food and biofuels as population increases and in response to a shift from high to low carbon emitting transport options. Global dependence on palm oil will continue to rise in years ahead owing to insufficient production of other oils and fats. It is therefore desirable that any assessment and discussion on the use of palm oil as food and transport fuels be driven by objective information in order to avoid creating unnecessary market disruptions.

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